

Appendix O

Flood Mitigation Alternatives

There are several different categories of flood hazard mitigation measures possible for the neighborhood and structures within the flood hazard areas.

ACQUISITION

Acquisition involves the municipal government purchasing and demolishing or moving (referred to as **relocation**) structures in the floodplain. The land is permanently deed-restricted for open space uses in order to restore the natural and beneficial functions of the floodplain. Structures that have been repetitively flooded, or experience floods with high flood depths, velocities greater than five feet per second, or long duration, tend to be the best candidates for acquisition. Acquisition is considered to be one of the most effective flood mitigation measures because it entirely removes structures from the pathway of floods.

Table O1: Additional Considerations for the Acquisition Option

Historic Property?	Historic properties are community assets which should be saved if possible. Further investigation into other options should be made. See the historic property matrix below.
Attached/Semi-Detached Housing or other closely spaced structure?	Acquiring one attached or semi-detached structure while leaving the other should be avoided. Attempt to acquire all at risk properties or find other alternative.
Adjacent to Open Space? Won't leave a "hole" in the neighborhood/streetscape?	This criterion is related to the previous criterion. Acquiring a patchwork of homes is undesirable without a long-term plan to acquire a cohesive block of structures. Acquiring structures that are adjacent to open space is the preferred mitigation option.
In poor condition?	Structures that are in poor condition are also more suitable for acquisition and demolition.
County or Municipality Able to Maintain the Property?	When structures are acquired using federal funding, the jurisdiction acquiring the property is required to maintain the property as open space in perpetuity. The jurisdiction acquiring the parcel must decide whether to maintain it as a greenway, park or allow it to revert back to natural area or to be maintained by other residents.

Acquisition is an effective mitigation measure, but can be damaging to intact neighborhoods. It is cost-effective for structures with high flood vulnerability; however, the process of obtaining the homeowner's approval, managing the implementation of the project, and accessing funding to complete the project are sometimes difficult.

BARRIERS

Barriers built of soil, called "berms," or concrete or steel, called "floodwalls" keep floodwaters from reaching a building. To be effective, earthen berms require three horizontal feet for each vertical foot. Concrete or steel floodwalls on the land of the property owner are also flood barriers that require only two feet or so of flood protection.

DRY FLOODPROOFING

Dry floodproofing entails making all areas falling below the base flood elevation impervious to water. Walls can be coated with a waterproofing compound or plastic sheeting. Openings such

as doors, windows, sewer lines, and vents, are closed, either permanently or with removable shields. Dry floodproofing is appropriate for buildings on sound slab foundations that are subject to less than three feet of flooding. Most building walls and floors are not strong enough to withstand the hydrostatic pressure from more than three feet of water. However, this method does not remove the structure and its contents out of the path of floods.

ELEVATION

Raising a building above the base flood elevation is the best on-site property protection method. Water flows under the building, causing little or no damage to the structure or its contents. Alternatives are to elevate on continuous foundation walls (creating an enclosed space below the building) or elevation on compacted earthen fill which can be more costly than elevating on an open foundation or continuous foundation walls. If raised eight or more feet, the lower area can be floodproofed and used for parking or storage.

Elevation is suitable where flood depths are less than 10 feet and have low velocity (less than 5 feet per second), and in areas that are not prone to ice floes or in “off-channel areas that have minimal potential for damaging floating debris. Elevation is not suitable for areas with long-duration flooding since accessing the structures would be difficult or unsafe in flood situations.

The most common elevation methods include:

- Elevating in place using solid wall, piles, or post foundations(see table below for more information on appropriate uses of foundation types);
- Filling in the basement and replacing the space with an elevated first floor;
- Abandoning the first floor and building a second floor;

Factors like foundation type, soil type and bearing capacity, weight of the house and lateral forces on the house from water (and other natural hazards such as winds and earthquake), condition of house, and height of the proposed elevation above the grade affect the actual method for elevating a specific house. These methods are best determined by the property owner and engineer on a case-by-case basis.

Table O2 shows broad guidelines for selecting one elevated foundation versus another.

Table O2: Elevation Methods Based on Existing Foundation Types and Other Conditions				
Condition	Existing Foundation Type			
	Basement	Crawlspace	Slab-on-grade	Open
Poor Soil				●
House is heavy or has lateral wind/earthquake/water forces	●	●		
Must be elevated high above grade	●	●		
Flood velocity greater than 5 ft/sec				●
Recommended Foundation Type for Elevated Structure	Solid walls	Solid walls	Solid walls	Piles, piers, posts

Politically and socially, elevation may be the most feasible option because it leaves neighborhoods intact, allows residential structures used primarily for water-related recreation activities like fishing and boating to remain near the water, and prevents damage from floods.

STRUCTURAL PROJECTS

Dikes, levees, dams, channelization, channel widening, stream realignment, seawalls, groins, and jetties are structures located away from the flood vulnerable structures. Structural projects have fallen out of favor as mitigation options because they tend to be expensive to build and maintain and can often increase flooding downstream or on the opposite side of the waterway. Furthermore, FEMA's mitigation programs emphasize nonstructural measures for mitigation of the flood hazard. These projects tend to be disruptive to the environment and can fail or be overtopped in sufficiently large flood events. Politically and administratively, structural projects require additional studies, public input, and can sometimes take a long time to implement.

WET FLOODPROOFING

Wet floodproofing entails letting flood waters inside the structure and moving any asset like furniture or household appliances out of harm's way. Wet floodproofing avoids the problems of pressure from floodwaters presented by dry floodproofing. Wet floodproofing is usually used for basements and garages and is not used for one-story houses because the flooded areas would be the living areas.

PROPERTY PROTECTION DECISION MATRIX

Mitigation measures need to be evaluated based on the flooding conditions at the site and the characteristics of the structure. After first finding information about foundation types in the tax database, planners should use the estimated depth of flooding for each structure and the decision matrix to identify appropriate mitigation measures. Properties that are at or above base flood elevation (other than those with basement foundations) are not considered in the following decision matrix because they are considered to be outside of the regulatory floodplain and are of low mitigation priority compared to other flood structures.

Table O3: Property Protection Decision Matrix		
First Floor Flood Depth	First Recommendation	Second Recommendation
Slab		
< 2 feet	Barrier	Dry Floodproof
≥ 2 feet	Elevate	Relocate/Acquire
> 9 feet	Relocate/Acquire	Relocate/Acquire
Crawlspace		
≥ 0 feet	Elevate	Elevate
> 9 feet	Relocate/Acquire	Relocate/Acquire
Basement		
≥ 0 feet	Elevate, fill in basement	Relocate/Acquire
> 9 feet	Relocate/Acquire	Relocate/Acquire
Pier/Pilings		
≥ 0 feet	Elevate	Elevate
> 9 feet	Relocate/Acquire	Relocate/Acquire

Another important consideration for flood hazard mitigation is historic properties. Historic properties are assets that help define communities and should be preserved where feasible. Table O4 presents additional considerations about the impact of hazard mitigation alternatives on historic properties. Although no properties listed on the National Register of Historic Places are

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within the flood hazard area, local officials must further consider the impact of mitigation options like acquisition and demolition or relocation on local historic resources.

Table O4: Considerations for Historic Properties

Hazard Mitigation Alternative	Reduction of Risk	Level of Impact to Historic Properties
Acquisition & Demolition	High	High
Relocation	High	Medium - High
Elevation	Medium	Medium
Dry Floodproofing	Low - Medium	Low - Medium
Wet Floodproofing	Low	Low
Stream Channel Improvements	Low	High
Levees & Floodwalls	Medium	Medium